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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁶ :

B02C 21/02, 1/04

A1

(11) International Publication Number:

WO 98/45043

(43) International Publication Date:

15 October 1998 (15.10.98)

(21) International Application Number: PCT/CA98/00349

(22) International Filing Date: 9 April 1998 (09.04.98)

(30) Priority Data:

9707289.6

10 April 1997 (10.04.97)

GB

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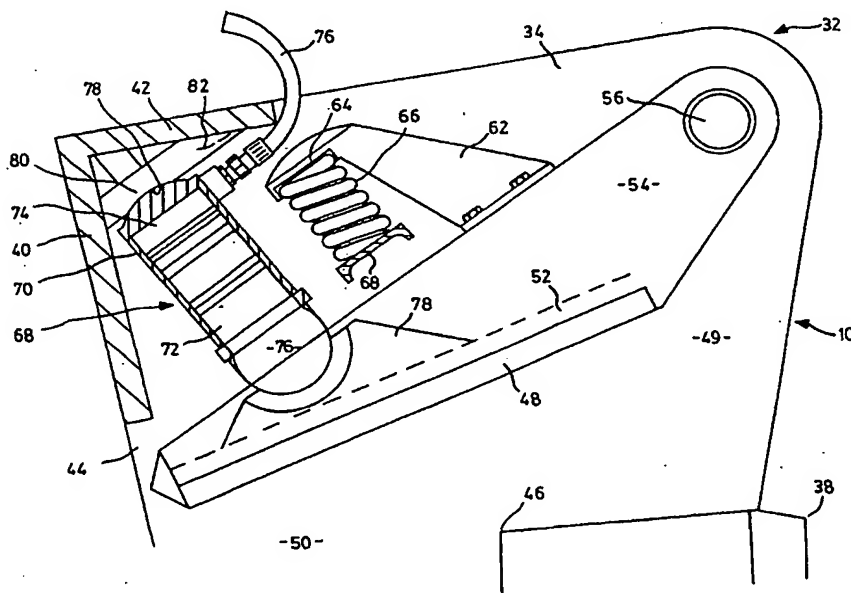
(81) Designated States: AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GE, GH, HU, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published

With international search report.

Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: PORTABLE CRUSHER



(57) Abstract

A portable rock crusher (10) is adapted for attachment to a boom (16) of an earthmoving vehicle (14). The crusher has a hopper (32) with a material inlet (49) and a material outlet (44) spaced from the inlet. A pair of jaws (46, 48) is located within the hopper and positioned between the inlet and outlet. The jaws are movable relative to one another to vary the spacing therebetween and an actuator (68) is provided to control relative movement between the jaws. Material moving from the inlet to the outlet thereby passes between the jaws and is crushed upon relative movement of the jaws to provide an aggregate at the outlet.

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Portable Crusher

BACKGROUND OF THE INVENTION

5 The present invention relates to a portable crushing device for preparing aggregate and the like.

When developing a remote site such as a mine or quarry, it is necessary to provide or improve roadways either leading to the site or within the site itself. Such roadways are necessary to allow the equipment used in developing the site to move freely and typically the roads are made from crushed rock that can be deposited, smoothed and compacted to provide
10 a serviceable roadway.

However, the very remoteness of or poor access to the site may make it impractical to have a rock crusher conveniently located to produce the aggregate for making a roadway. Moreover, a conventional mobile rock crushing plant may be too large or heavy for use within the site until such time as the roads have been developed.

15 In most locations there is an ample supply of blasted stone available but it may be impractical or uneconomical to have a rock crusher located at the site. Even if a crusher is available, it is inconvenient to carry the blasted rock from the mine or quarry, crush it to a size suitable for building a road, and then transport it back to the mine for building a roadway.

20 It is therefore an object of the present invention to obviate or mitigate the above disadvantages.

SUMMARY OF THE INVENTION

25 In general terms, the present invention provides a portable crusher for attachment to a boom of an earthmoving vehicle. The crusher has a hopper with a material inlet and a material outlet spaced from the inlet. A pair of jaws is located within the hopper and positioned between the inlet and outlet. The jaws are movable relative to one another to vary the spacing therebetween and an actuator is provided to control relative movement between the jaws. Material moving from the inlet to the outlet thereby passes between the jaws and is
30 crushed upon relative movement of the jaws to provide an aggregate at the outlet.

Preferably the actuator is a hydraulic actuator and one of the jaws is fixed while the other may pivot relative to the hopper under the control of the actuator.

It is also preferred that the jaws are biased apart and that the biasing is provided by a mechanical spring.

By providing a crusher that may be attached to the boom of an earthmoving vehicle, it is possible to transport the crusher prior to improvement of the roads to the location at which the raw materials are available for crushing into aggregate. Moreover, the feed of material between the inlet and outlet may be controlled by operation of the boom-leveling mechanism and the hopper may be utilized to transport the crushed material if convenient.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the invention will now be described by way of example only with reference to the accompanying drawings, in which

Figure 1 is a side elevation of a hydraulic crusher mounted on a wheeled vehicle;

Figure 2 is a section of the crusher shown in Figure 1;

Figure 3 is a perspective view of a jaw utilized in the crusher shown in Figures 1 and

Figure 4 is a side view similar to Figure 2 of an alternative embodiment of crusher;

Figure 5 is a side view similar to Figure 1 of a still further embodiment of the crusher; and

Figure 6 is a side view similar to Figure 1 of a yet further embodiment of crusher.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring therefore to Figure 1, a hydraulic crusher 10 is connected to a boom assembly 12 of a wheeled earthmoving vehicle 14. The boom assembly 12 includes a pair of laterally spaced booms 16 pivotally connected to towers 18 and movable about the pivot point with the towers by means of lift cylinders 20. The boom assembly 12 also includes a leveling linkage 22 comprising a leveling cylinder 24 connected to a pair of links 26, 28. The boom assembly 12 and wheeled vehicle 14 are conventional and well known in the earthmoving field and need not be described in further detail. It will of course be understood that other configurations of wheeled vehicle or tracked vehicle may be utilized to support the crusher 10.

The crusher 10 is provided with mounting points 28, 30 for connection through respective pins to the lift arms, or booms, 16 and link 26. In configuration, the mounting

points 28, 30 correspond to those of a conventional bucket such as may be used with the boom assembly 12 so that the vehicle 14 may be used with the crusher 10 or with a conventional bucket assembly.

Referring to Figure 2, the crusher assembly 10 comprises a hopper generally indicated at 32 and having a pair of laterally spaced side walls 34 interconnected by a floor 36. The floor 36 projects forwardly from the side walls 34 to provide a tapered lip 38 to facilitate ingress of material into the hopper 32. The side walls 34 are also connected at the upper rear edge by a rear wall 40 and a top wall 42. The end wall 40 terminates prior to the floor 36 to provide a transverse elongate outlet 44.

A pair of jaws 46, 48 is located within the hopper 32 with the lower jaw 46 secured through bolts 50 to the floor 36. The jaw 48 is secured to a transverse plate 52 which extends between a pair of arms 54. The arms 54 are located adjacent respective side walls 34 and are pivotally mounted to the side walls on pins 56. The jaw 48 may therefore pivot about the pins 56 toward and away from the jaw 46. The forward end of the jaws 46, 48 are thus spaced apart to define an inlet 49 that is aligned with but spaced from the outlet 44.

The jaws 46, 48 are shown in more detail in Figure 3 and are formed with a ridged upper surface 58 having triangular teeth 60 which progressively increase in height and merge from the front to rear. The form of the upper surface 58 is merely exemplary and is a standard form of crusher jaw such as that made by ESCO Canada Ltd. and therefore need not be described in further detail. The bolts 50 are arranged on standard centers so that different forms of crusher jaw can be utilized depending upon the material to be crushed.

Referring once again to Figure 2, each of the arms 54 has a bracket 62 on the side opposite to the jaws 48 and which extends rearwardly. The bracket 62 has a projecting lug 64 which receives one end of a coil spring 66. The opposite end of the coil spring 66 is supported upon a transverse bar 67 which extends between the side walls 34. The spring 66 is a compression spring which acts to bias the arm 54 about pin 56 to attain the maximum spacing between the jaws 46, 48.

Relative movement between the jaws 46, 48 is controlled by an actuator generally indicated at 68. The actuator 68 includes a hydraulic cylinder 70 and a piston 72 slidable within the cylinder 70. Hydraulic fluid is supplied to a chamber 74 defined between the piston 72 and cylinder 70 through a pipe 76 from a convenient service location upon the vehicle 14. Flow through the pipe 76 is controlled by a valve assembly that causes chamber

74 to expand upon admission of fluid or contract under the influence of the spring 66 upon egress of fluid. The piston 72 has a ball 76 formed at one end that engages a socket 78 mounted on the plate 52. The opposite end of the actuator 68 is domed as indicated at 78 and supported in a part-cylindrical recess 80 formed in a cross-bar 82 extending between the back plate 40 and top plate 42. The ball 76 and socket 78 together with the dome 78 and recess 80 permit relative rotational movement as the arm 54 swings about the pin 56 to inhibit bending stresses upon the actuator.

In operation, the attitude of the crusher 10 is adjusted through the boom assembly 12 such that the floor 36 is flush with the ground upon which a stockpile of stones is located.

The vehicle 14 is advanced so that material enters the hopper 32 through an inlet 49 defined between the jaw 48, the side plates 34 and the floor 36. The boom assembly 12 is then crowded to rotate the crusher about the pivot points 28 of the boom 16 so that the stones indicated generally as S fall between the jaws 46, 48. Although some of the stone S is sufficiently small to pass between the jaws 46, 48 and out of the outlet 44, the majority is held between the jaws 46, 48. The hydraulic fluid is then supplied through the pipe 76 to expand the chamber 74 and pivot the arm 54 about the pin 56. The jaws move toward one another and crush the stones S located between the jaw causing them to shatter into smaller fragments. Those fragments then pass between the jaws and through the outlet 44 to provide a supply of crushed stone.

The actuator 68 is cycled between extended and retracted positions on a regular basis, typically 60 Hz to provide a continuous crushing operation. The stones S thus feed from the hopper 32 between the jaws 46, 48 and are fragmented to pass out of the outlet 44.

The spring 66 opposes rotational movement of the arm 54 under the influence of the actuator 68 and thus returns the arm to the position in which the jaws 46, 48 are separated.

This enables the actuator 68 to be single acting and a relatively simply cycling valve used to supply fluid through the pipe 76.

Once the stone S has been crushed, the vehicle 14 may be repositioned to acquire additional stones and crush them in a similar manner. In the event that a stone S becomes stuck within the jaws, the crowd cylinder 24 may be extended to allow the stone S to drop out of the hopper 32.

It will be seen therefore that by mounting the crusher assembly on the boom 16, it is possible to transport the crusher to a convenient location to perform crushing operations. The

provision of the spaced jaws 46, 48 between the inlet 49 and outlet 44 of the hopper 32 enables the stones to be crushed on a continuous basis and to utilize gravity to induce the flow through the crusher jaws. Upon completion of the crushing operation, the hopper 32 may be utilized to transport the crushed material to an appropriate site or may be used to compact and smooth the crushed material in a manner similar to that with a conventional bucket assembly. It will be appreciated that the mounting points may be chosen to conform to one of a standard configuration of machine, for example, the hopper can be configured to be used with a 360° Excavator or with a rear mounted backhoe by suitable positioning of the mounting points.

A further embodiment of crusher is shown in Figure 4 in which like components will be identified with like reference numerals with a suffix "a" added for clarity. In the embodiment of Figure 4, the crusher 10a has a lower jaw 46a and an upper jaw 48a to direct material from an inlet 49a to outlet 44a in the rear wall of the hopper 32a. Spring 66a extends between a bracket 62a on the arm 54a and a transverse bar 90. The spring 66a is a tension spring having hooked ends secured in eyes 92 on the bracket 62a and bar 90 respectively. Rotation of the arm 54a about the pin 56a will cause extension of the spring 66a to bias the arm away from the lower jaw 46a.

An actuator 68a is located within the hopper 32a and has a piston 72a with a ball 76a received in socket 78a. Fluid is supplied to a chamber 74a from a reciprocating pump generally indicated at 94. The pump 94 has a piston 96 slidable within a cylinder 98 which is directly connected to the chamber 74a. The piston 96 is connected to a connecting rod 100. The connecting rod is pivotally secured to a crank 102 which is secured to an output shaft of a hydraulic motor 104. The motor 104 can be of any convenient form and receives hydraulic fluid through pipe 76a from a service on the vehicle.

The operation of the crusher 10a is similar to that described above with cyclic extension and retraction of the actuator 68a being induced by flow of fluid between the interconnected chambers 98 and 74a as the piston 96 reciprocates under the control of the crank 102. The cylinder 98 is sized to produce the requisite stroke for the piston 72a and produce the oscillatory motion of the arm 54 of the arm 54a about the pin 56a.

A further embodiment is shown in Figure 5 in which like reference numerals will again be utilized to denote like components with the suffix "b" added for clarity. The crusher 10b has a pair of jaws 46b, 48b with the upper jaw 48b mounted on arm 54b to pivot about

the pin 56b. The arm 54b is biased away from the jaw 46b by a coil spring 66b acting through a rod 110. The rod 110 extends parallel with the back wall 40b and is pivotally connected by pin 112 to a tongue 114 on the arm 54b. The rod 110 passes through a hole formed in a bracket 114 that is secured to the rear wall 40b and the spring 66b located
5 between the bracket 114 and a cap 116 threaded onto the rod 110. Pivotal movement of the arm 54b will thus cause compression of the spring 56b between the bracket 114 and the cap 116.

Rotation of the arm 54b is induced through a toggle mechanism generally indicated at 120 connected to an actuator 68b. The toggle mechanism 120 includes a pair of links 122,
10 124 which are pivoted by pins 126 to opposite sides of a boss 128. The opposite end of link 122 is secured through a pin 130 to a bracket 132 on the cross bar 80b at the vertex of the hopper 32b. The link 124 is similarly connected through pin 134 and plate 136 to the arm 54b.

The boss 128 is secured to the piston 72b of the actuator 68b which in turn is slidable
15 within the cylinder 70b. Fluid to the actuator 68b is supplied through control pipe 76b from suitable valving to cause reciprocation of the piston 72b within the cylinder 70b.

With the links 122, 124 aligned, the jaw 48b is closest to the jaw 46b. As the piston rod 72b reciprocates, the boss 128 is displaced laterally causing the links 122, 124 to pivot about their respective pin connections and thus cause the arm 54b to rotate about the pin 56b.
20 A crushing action is thus provided by the cyclic reciprocation of the piston rod within the cylinder 70b to reduce the stone S to an aggregate.

The stroke of the actuator 68b may be adjusted so that at one limit the links 122, 124 are aligned as shown in Figure 5 and at the other limit, the boss is displaced as shown by the chain-dotted lines in Figure 5. An alternative control is to permit the stroke of the actuator
25 68b to move the links 122, 124 past the aligned position so that the boss 128 is moved to either side of the position indicated in chain dot lines. As the links move over center, the jaws will move apart. As a result, two oscillations of the jaws will occur for each stroke of the cylinder.

The initial spacing between the jaws 46b and 48b can be adjusted by means of spacers
30 indicated at 138 located beneath the plate 136 with a corresponding adjustment made to the position of the cup 116 on the rod 110. In this way, different nominal sized aggregate can be produced.

A further embodiment is shown in Figure 6 in which like components will be identified with like reference numerals with the suffix "c" added for clarity. In the embodiment shown in Figure 6, actuator 68c is in the form of a double-acting hydraulic motor having a piston 72c and a cylinder 70c. The actuator 68c acts directly between the bracket 80b and the arm 54c. The hopper 32c is provided with a front wall 140 that extends from the upper apex of the hopper 32c downwardly beyond the pivot pin 56c. As such, the front wall 140 shields the actuator 68c.

Oscillation of the jaws 46c and 48c is controlled by the actuator 68c which is caused to reciprocate cyclically by fluid supplied from a suitable valve through the pipes 76c. The cycling of the actuator 68 can be obtained using one of a number of conventional cycling operations. For example, a spring-biased solenoid-operated valve can be utilized with drive to the solenoid switch by proximity sensors associated with the piston rod or by using a mechanical linkage connected between a reversing valve and the upper jaw 48 to reverse flow to the actuator.

In each of the above arrangements, the typical minimum spacing between the jaws 46c, 48c is in the order of 2 inches although spacings of up to 3 or more inches can be contemplated where relatively large aggregate is required. Typically the displacement of the jaws between maximum and minimum spacing would be in the order of $\frac{1}{2}$ - 1 inch to provide the requisite crushing action. As noted above, the actuator 68 produces an oscillatory motion in the order of 60 Hz through suitable valving. Using a 10" diameter cylinder, adequate crushing force is obtained at 500 psi.

It will be seen therefore that by providing a compact mechanism located within a hopper that may be attached to an earthmoving vehicle, a portable crusher is provided that can be used at remote locations to facilitate the production of aggregate.

Although the invention has been described with reference to certain specific embodiments, various modifications thereof will be apparent to those skilled in the art without departing from the spirit and scope of the invention as outlined in the claims appended hereto.

**THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE
PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:**

1. A portable crusher for attachment to a boom of an earthmoving vehicle, said crusher
5 having a hopper with a material inlet and a material outlet spaced from said inlet, a pair of
jaws within said hopper positioned between said inlet and outlet, said jaws being moveable
relative to one another to vary the spacing therebetween and a power source to control
relative movement therebetween, whereby material moving from said inlet to said outlet
passes between said jaws and is crushed upon relative movement therebetween.

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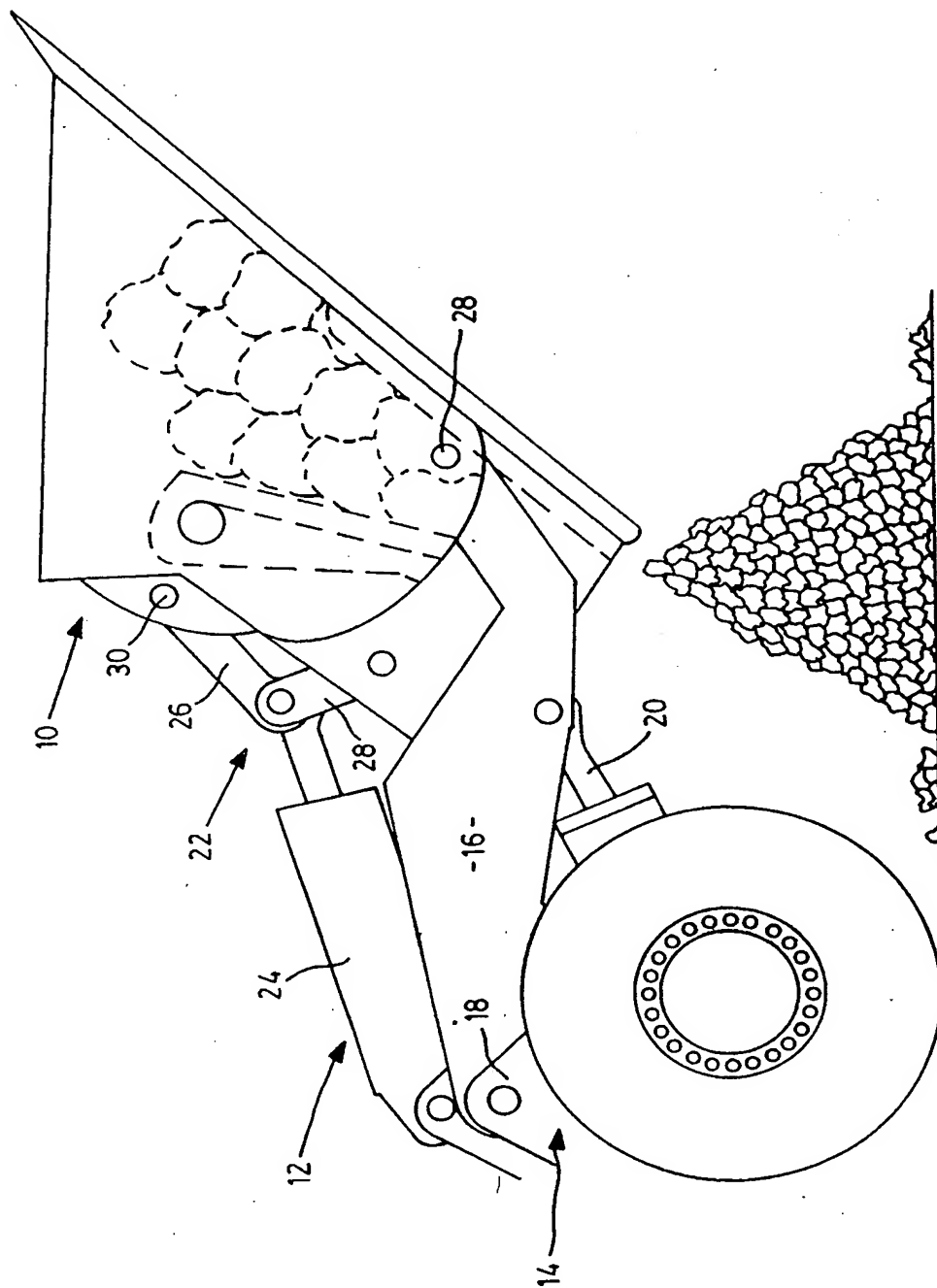


FIG. 1

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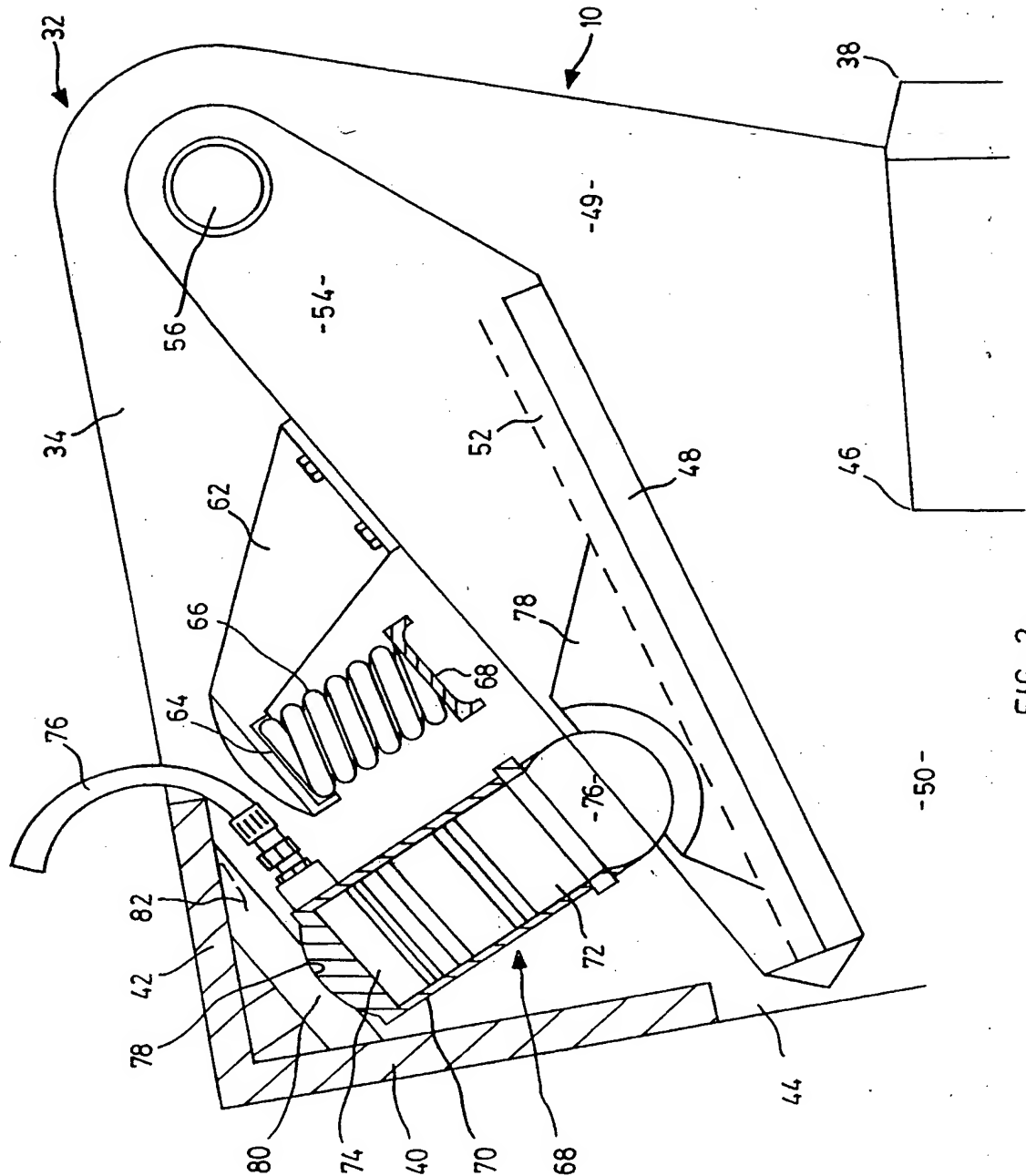


FIG. 2

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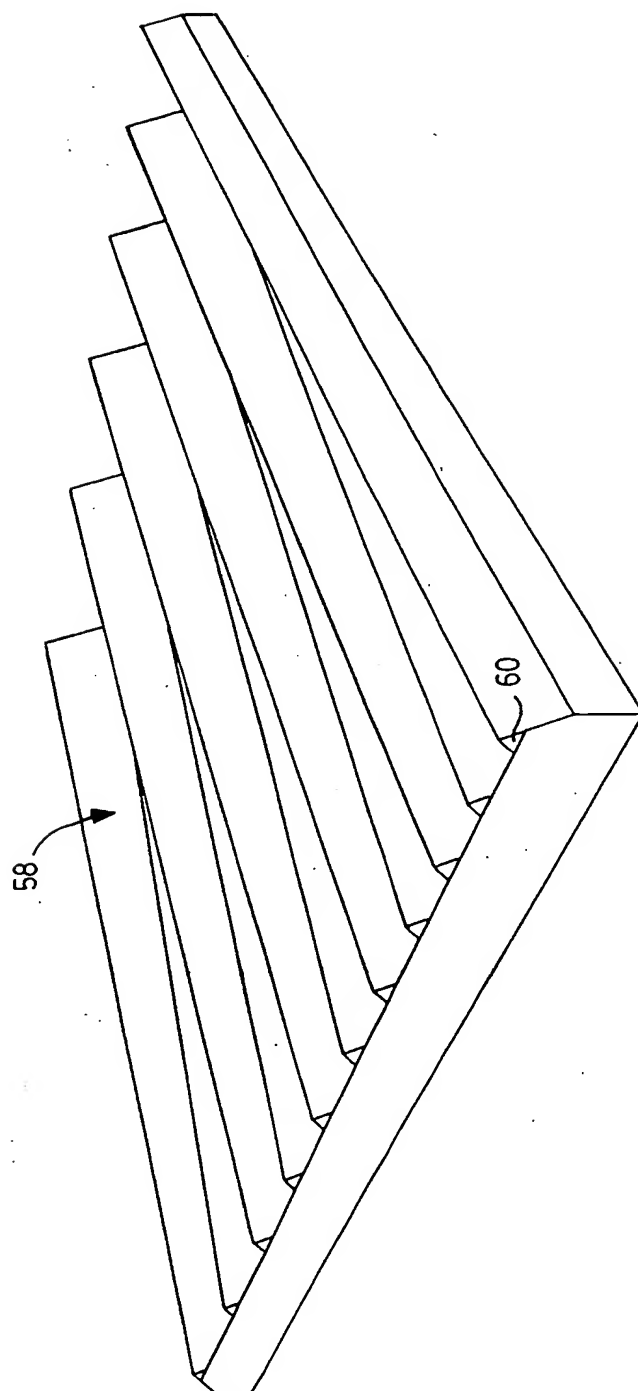


FIG. 3

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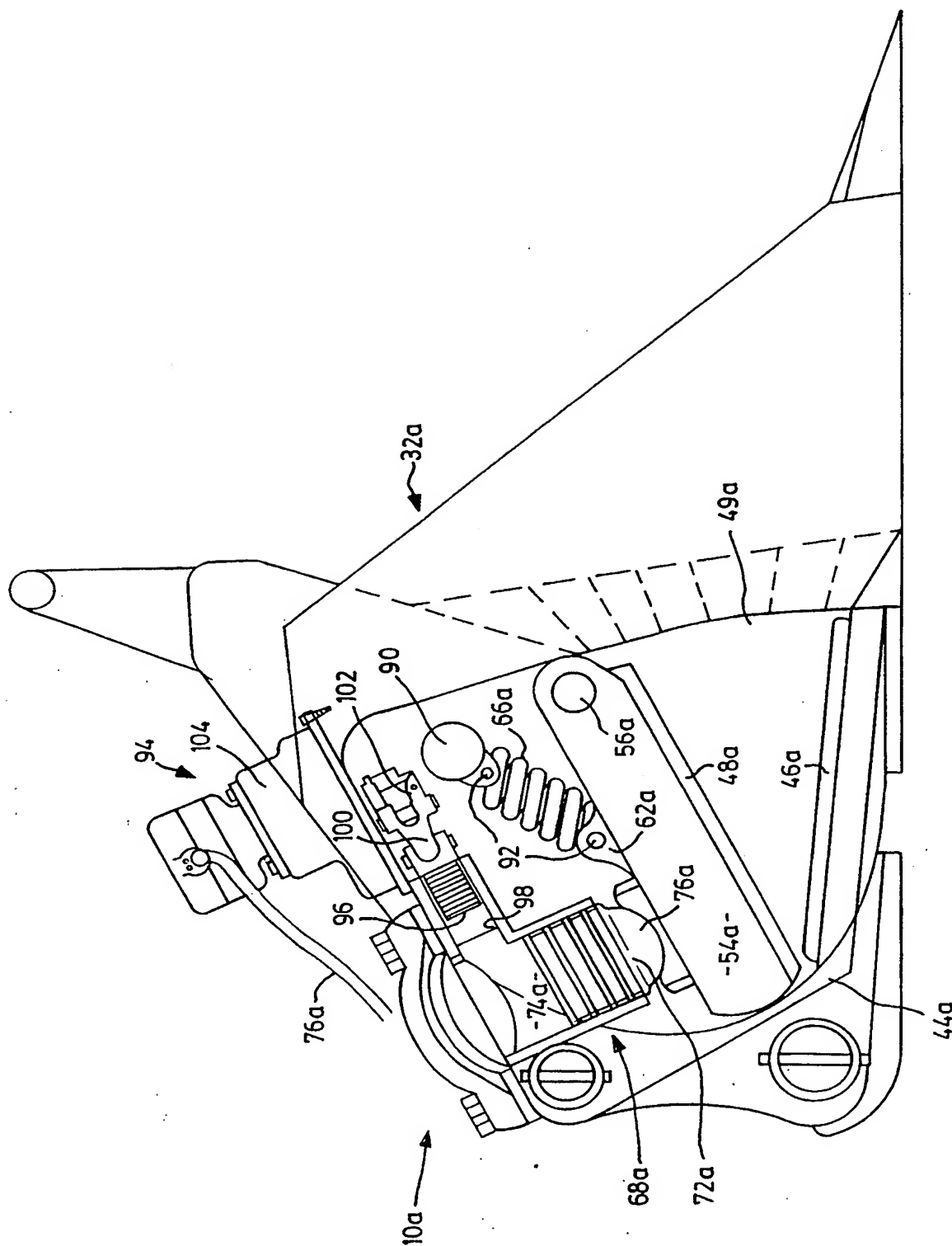


FIG. 4

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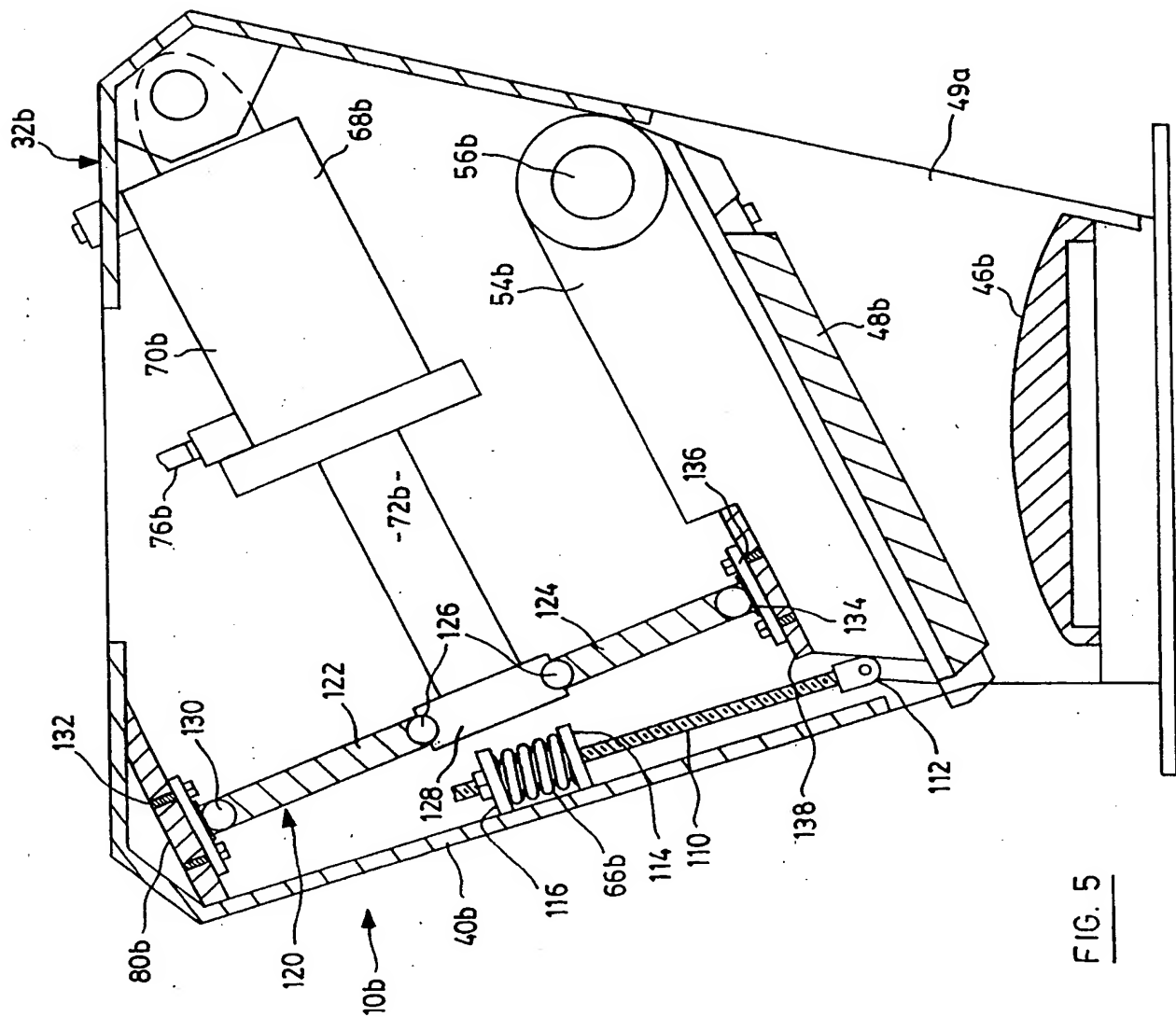
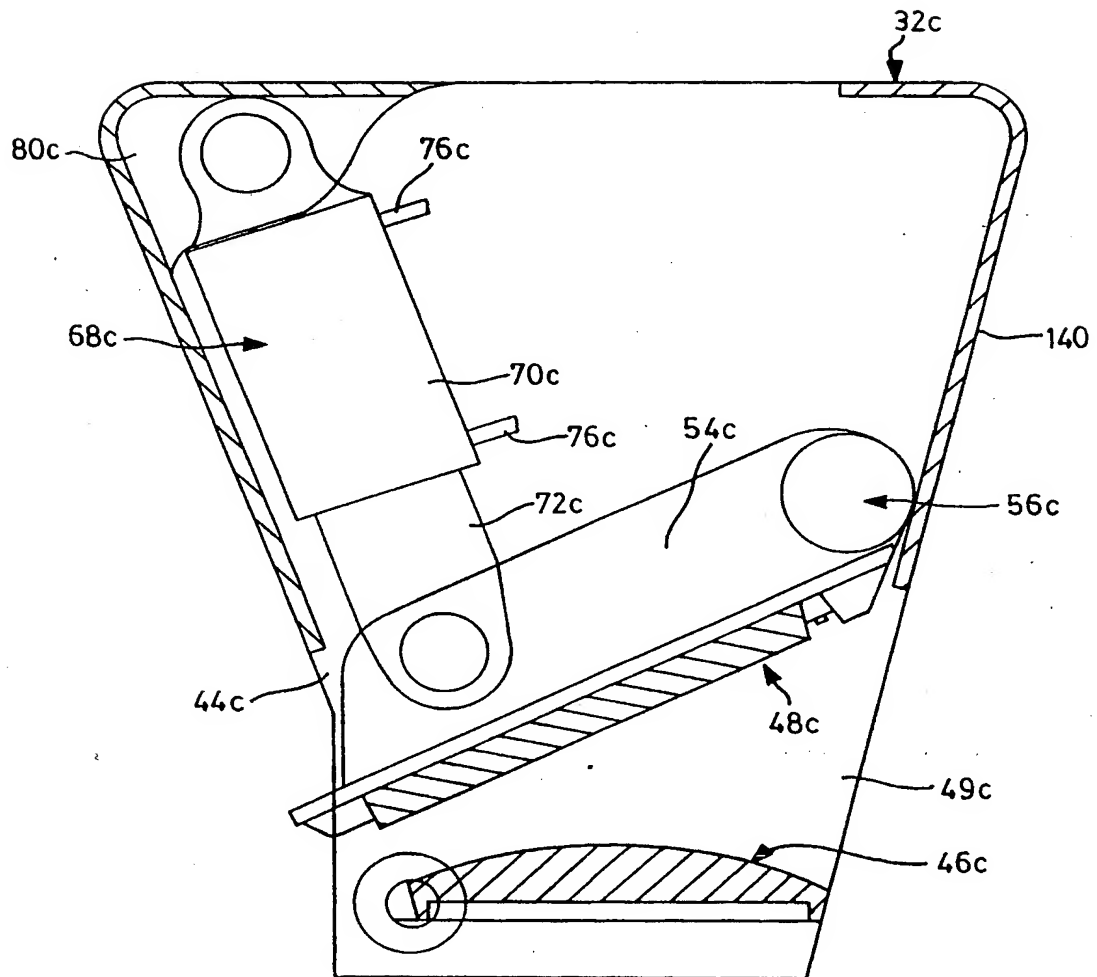


FIG. 5

FIG. 6

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INTERNATIONAL SEARCH REPORT

International Application No
PCT/CA 98/00349

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B02C21/02 B02C1/04

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B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B02C E02F E01C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 441 415 A (HAWKINS PETER A T) 10 April 1984 see abstract; figures 1-3 see column 4, line 19 - line 30 ---	1
X	US 3 959 897 A (MAY WILLIAM P) 1 June 1976 see the whole document ---	1
P, X	EP 0 798 421 A (JACTY ENGINEERING CO LTD) 1 October 1997 see the whole document ---	1
Y	GB 2 190 857 A (KJERNSBEKK HAKON) 2 December 1987 see the whole document ---	1
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Date of the actual completion of the international search

6 August 1998

Date of mailing of the international search report

17/08/1998

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INTERNATIONAL SEARCH REPORT

national Application No
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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Y	<p>US 4 697 509 A (LABOUNTY ROY E) 6 October 1987 see abstract; figures 1-3 see column 1, line 6 - line 10 -----</p>	1

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Information on patent family members

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